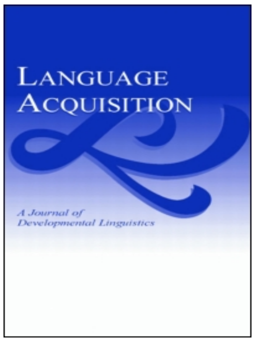
Autism spectrum disorder and specific language impairment: overlaps in syntactic profiles

Durrlemann, Stéphanie; Delage, Hélène



Language Acquisition

ISSN: 1048-9223 (Print) 1532-7817 (Online) Journal homepage: https://www.tandfonline.com/loi/hlac20

Autism Spectrum Disorder and Specific Language Impairment: Overlaps in Syntactic Profiles

Stephanie Durrleman & Hélène Delage

To cite this article: Stephanie Durrleman & Hélène Delage (2016) Autism Spectrum Disorder and Specific Language Impairment: Overlaps in Syntactic Profiles, Language Acquisition, 23:4, 361-386, DOI: 10.1080/10489223.2016.1179741

To link to this article: https://doi.org/10.1080/10489223.2016.1179741

Accepted author version posted online: 16 May 2016.
Published online: 29 Jul 2016.

LANGUAGE ACQUISITION
2016, VOL. 23, NO. 4, 361–386
http://dx.doi.org/10.1080/10489223.2016.1179741

Autism Spectrum Disorder and Specific Language Impairment: Overlaps in Syntactic Profiles

Stephanie Durrleman and Hélène Delage

University of Geneva

ABSTRACT

This study investigates syntax in Autism Spectrum Disorders (ASD), its parallelism with Specific Language Impairment (SLI) and its relation to other aspects of cognition. We focus on (1) 3rd person accusative clitic (ACC3) production, a clinical marker of SLI hypothesized to relate to WM, and (2) 1st person accusative clitic (ACC1) production, preserved in SLI but hypothesized to be affected in ASD due to Theory-of-Mind (ToM) difficulties. Participants included 21 individuals with ASD (aged 5-16), 22 individuals with SLI (aged 5-16), age-matched and younger TD controls (*N* = 44). Clinical groups showed similar deficits for ACC3 and general morphosyntax. Closer analysis revealed that a subgroup of children with ASD displayed intact grammar except for ACC1, where children with SLI performed well. Better ToM scores implied better ACC1 scores in ASD. Difficulties with WM emerged for ASD and SLI and correlated only with performance on ACC3. Non-verbal reasoning was unrelated to syntactic measures.

ARTICLE HISTORY
Received 25 July 2014
Accepted 15 April 2016

1. Introduction

Children with Autism Spectrum Disorder (ASD) and those with Specific Language Impairment (SLI) share the common feature of poor spoken communication skills (DSM-V, American Psychiatric Association [APA] 2013). Although delays and deficits in language are not core features of ASD, as they are of SLI, they are nevertheless generally among the first symptoms of the autistic condition (Kurita 1985; Short & Schopler 1988; Lord & Paul 1997).

Being a spectrum disorder, language abilities in ASD show great variation from one individual to the next, ranging from mutism to fluent speech (Lord et al. 2006). Throughout the spectrum, however, pragmatic impairments remain evident (Tager-Flusberg 1996), explaining why a vast amount of research investigating this component has been conducted over the years (Baltaxe 1977; Happé 1995; Ozonoff & Miller 1996; Baron-Cohen 1997; Chin & Bernard-Opitz 2000; Reddy, Williams & Vaughan 2002). In contrast, comparatively few studies have examined grammatical abilities in autism to date, with some suggesting that subsets of children with ASD display impairments in grammar reminiscent of SLI (Roberts, Rice & Tager-Flusberg 2004; Kjelgaard & Tager-Flusberg 2010; Zebib et al. 2013).

SLI is also a condition displaying considerable heterogeneity (Tomblin 2011), and there are reports that some children with SLI show not only the hallmark of grammatical impairments but also pragmatic difficulties (Bishop 2003; Ketelaars, Cuperus, Jansonius, et al. 2009; Ketelaars, Cuperus, Van Daal, et al. 2009). According to the DSM-IV, SLI and ASD were mutually exclusive diagnoses, since SLI was a "specific" developmental disorder. However, this is not the case in the DSM-V. The question then arises to what extent there may be an overlap between these disorders.

CONTACT Dr. Stephanie Durrleman stephanie.durrleman@unige.ch University of Geneva, Faculty of Psychology and Educational Sciences, 40 boulevard du Pont d'Arve, 1205 Geneva, Switzerland.

Studies focusing on this question have reported above-chance co-occurrence of SLI and ASD, arguably because these conditions may share the same etiology (Bishop 2010). Under this view, it is expected that the language phenotype of a subgroup of children with ASD is the same as the phenotype for SLI (Tager-Flusberg 2006).

The current work builds on the reported grammatical parallelisms between ASD and SLI and asks whether a subset of French-speaking children with ASD shows difficulties with the production of object clitics, claimed to be a clinical marker of SLI in French (e.g., Paradis, Crago & Genesee 2003; Parisse & Maillard 2004; Jakubowicz & Tuller 2008; Tuller et al. 2011)[1] and as yet scarcely explored in studies of autism.

1.1. *Grammatical abilities in children with ASD: An overview*

Studies of grammar in autism have yielded conflicting findings. Early work exploring grammatical ability with measures of spontaneous language production (such as The Mean Length of Utterance or The Index of Productive Syntax) have claimed that children with ASD show similar grammatical competency to that of typically developing (TD) peers matched on mental age (Bartak, Rutter & Cox 1975; Pierce & Bartolucci 1977; Tager-Flusberg et al. 1990). More recent work involving fine-tuned experimental tasks has shed light on the presence of specific grammatical deficits not clearly attributable to general cognitive abilities (Roberts, Rice & Tager-Flusberg 2004; Terzi et al. 2012; Perovic, Modyanova & Wexler 2013; Zebib et al. 2013). This is reminiscent of SLI, a condition where a child fails to develop language normally in the absence of other cognitive deficits. Recent reports that language and cognition may also be dissociated in ASD have led various authors to debate the nature and extent of overlap between ASD and SLI (Tager-Flusberg 2004; Bishop 2010; Tomblin 2011). Some scholars now claim that subgroups of children with ASD present syntactic profiles similar to those associated with SLI (e.g., Kjelgaard & Tager-Flusberg 2010; Roberts, Rice & Tager-Flusberg 2004; Tager-Flusberg 2006; Riches et al. 2010; Zebib et al. 2013).

Among these studies, issues regarding the overlap between ASD and SLI remain to be clarified. For example, in the study by Riches et al. (2010), adolescents with ASD (mean age 14;08, N = 16) with a close-to-average nonverbal IQ were compared to adolescents with SLI (mean age 15;03, N = 14) and a group of age matched TD adolescents (mean age 14;04, N = 17) on a sentence-repetition task involving both subject and object relative clauses (RCs). The authors showed that participants with SLI and a language-impaired group of participants with ASD showed similar language profiles, with both clinical groups performing less accurately than TD controls. These authors, however, also pointed out that the ASD group seemed less affected than the SLI group by the complexity of the sentences because they were less prone to transform the more difficult object RCs into subject RCs. As an illustration, an object RC such as "the granny that the thief robbed" involves a more complex, noncanonical object-subject-verb structure than the corresponding simpler subject RC "the thief that robbed the granny," which respects subject-verb-object word order. Transforming the former into the latter is thus interpreted as indicative of avoidance of the syntactic complexity associated with object RCs as compared to a subject RC. The predominance of this strategy of avoidance in SLI participants compared to those with ASD (while other error types, such as incomplete or null responses, remained similar among the groups) is consequently taken to suggest that the language-impaired ASD group shows a lesser morphosyntactic deficit than the SLI group in the same age range.

The finding that language impairment in ASD is less pronounced than it is in SLI contrasts with other reports, such as that provided by Roberts et al. (2004). These authors showed that for the grammatical marking of tense, a language-impaired subgroup of children with ASD (aged 8–9) suffered from an even more pronounced difficulty than an SLI group in the same age range (taken from Rice, Wexler & Cleave 1995). The difference in reports may stem from the distinct IQ levels of the

[1]In other languages, it is not the actual production of clitics that is problematic, as reported for French, but rather clitic misplacement (see Theodorou & Grohmann 2015).

ASD groups as compared to the SLI groups (recall that participants in Riches et al. [2010] were of largely normal nonverbal IQ, in contrast to those of Roberts et al.) Indeed, linguistic skills and nonverbal IQ have been found by some authors to be correlated (e.g., Howlin 1984; Tager-Flusberg et al. 1990). Still, as has been noted, certain studies have maintained that IQ does not explain formal language abilities in ASD. For example Terzi et al. (2012) studied 20 high-functioning Greek children with autism (nonverbal IQ above 80; age range: 5–8 years old) and found their comprehension of object clitic pronouns to be significantly weaker than the control group of similar chronological age. Their follow-up study (Terzi et al. 2014), which included 16 of the initial participants, further indicated significant difficulties for the production of clitics, suggesting that certain language areas may be vulnerable despite high nonverbal abilities. Zebib et al. (2013) also claimed that the nonverbal abilities of their 20 participants on the autistic spectrum (mean age 8;07) as measured by Raven's Matrices were generally not correlated with formal language abilities. More specifically, Zebib et al. reported that, regardless of IQ levels, a large proportion of their participants showed moderate-to-severe deficits in morphosyntax as revealed both by standardized assessments as well as an elicited production of questions formed with interrogative words. These results show that both ASD and SLI populations tended to avoid complex syntactic structures, in particular those involving noncanonical orders.

To sum up, more research is necessary so as to determine the nature of the grammatical deficit in (subgroups of) individuals with ASD, whether or not syntactic development is related to IQ, and how it may be similar to that found in other cases of language pathology such as SLI. In addition, researchers to date have mainly focused on English-speaking individuals with ASD (although see, e.g., Fortunato-Tavares 2012; Zebib et al. 2013; Terzi et al. 2012, 2014; Schaeffer, in press). Clinical markers of language impairment in other languages than English are consequently virtually absent from the ASD literature. One such marker in many Romance languages is accusative clitic pronoun production (Bortolini et al. 2002; Hamann, Rizzi & Frauenfelder 1996; Paradis, Crago & Genesee 2003; Parisse & Maillard 2004; Gavarro 2012; Avram, Sevcenco & Stoicescu 2013; Arosio et al. 2014), which is the focus of the present investigation.

1.2. *Accusative clitic pronouns and their acquisition*

English and French share the canonical word order: subject-verb-object. Both full lexical objects (1a) and accusative pronouns (1b) in English occur in their canonical, postverbal position. However, in French, while full lexical objects respect the canonical ordering of the language (2a), the corresponding cliticized accusative pronouns do not and instead occur preverbally (2b):

(1a) John sees **Mary**

(1b) John sees **her/it**

(2a) Jean voit **Marie**
John sees Mary

(2b) Jean **la** voit
John **her/it** sees

This difference between English pronouns such as *her* and French clitic pronouns such as *la* has been explained in terms of the former being a "strong" pronoun and the latter a weak one. Weak pronouns have to undergo "syntactic movement," an operation that contributes to complicating their acquisition (see Cardinaletti & Starke 1999, for more on the distinctions between strong and weak pronouns). As a result, third person accusative clitics such as in (2b) emerge relatively late in typical development (Clark 1985; Hamann, Rizzi & Frauenfelder 1996; Jakubowicz & Rigaut 2000; Chillier et al. 2001). Indeed, children of a mean age of 3;02 years have been found to omit over half of such objects from their utterances (Van der Velde 2003), preferring to not specify the object at all, which is ungrammatical except in certain contexts (Fonagy 1985; Pérez-Leroux, Pirvulescu & Roberge 2008; Tuller et al. 2011), or to rather produce full lexical objects instead, which is grammatical but pragmatically infelicitous. It isn't until around 5 to 8 years of age that TD children approach ceiling production for these elements (Delage, Durrleman, & Frauenfelder in press; Zesiger et al. 2010, Tuller et al. 2011; Varlokosta et al. 2016). It is thus unsurprising that such pronouns are particularly problematic for children with SLI (Jakubowicz et al. 1998; Chillier et al. 2001; Hamann et al., 2003; Paradis & Crago 2003) and are now recognized to be clinical markers for this condition in French (Paradis, Crago & Genesee 2003; Parisse & Maillard 2004) as well as other Romance languages (Bortolini et al. 2002; Gavarró 2012; Avram, Sevcenco & Stoicescu 2013; Arosio et al. 2014). A study of the production of these elements is virtually absent from the ASD literature, save one study from Greek suggesting that clitics may indeed be a vulnerable domain in this condition (Terzi et al. 2014).

Our study focuses on the production of third person accusative clitic pronouns in French-speaking children with ASD compared to those with SLI. The aim is to contribute to elucidating the nature and extent of overlapping grammatical deficits in these conditions. If a subgroup of children with ASD suffers from similar syntactic difficulties to children with SLI, we expect that the production of accusative clitics will pose a problem for these children, leading to avoidance of these elements.

In addition to third person accusative clitics, we also investigate first person accusative clitics (3). In contrast to the vast amount of studies that have focused on third person accusative clitics in TD and SLI, few investigations have been conducted for clitics other than those of the third person. However, authors who have examined first person clitics have observed that they emerge earlier than those of the third person (2), (Tsimpli & Mastropavlou 2007; Avram & Coene 2008; Coene & Avram 2011; Tuller et al. 2011; Delage, Durrleman & Frauenfelder in press).

(3) Jean **me/te** voit
John me/you sees
'John sees me/you'

In a longitudinal study of the speech of two monolingual Romanian children (aged 1–3), Coene & Avram (2011) found that in obligatory clitic contexts, third person clitics were frequently omitted until 3 years of age, while those of the first (and second) person were present from the earliest utterances. This pattern of asymmetric omission was also observed for Greek-speaking children with SLI aged 3;05 to 7 years (Tsimpli 2001) and for adult L2 learners (Tsimpli & Mastropavlou 2007).

Tuller et al. (2011) investigated various clitic types in French-speaking adolescents suffering from different pathologies. Their elicited production study was conducted with 36 TD children (aged 6 and 11 years) and 71 adolescents with atypical language development (age range 11–20 years). The clinical population was composed of three groups: SLI, mild-to-moderate hearing loss (MMHL), and Rolandic Epilepsy (RE). The TD 11-year-old group was the only one to perform at ceiling for all clitic pronouns. All clinical groups, as well as the youngest TD group (aged 6), showed marked difficulty with third person accusative clitics. More specifically, the TD 6-year-olds obtained 70.3% for accusative clitics of the third person (noted "ACC3") while for those of the first person (noted "ACC1") they obtained 90.6%. Similarly, the group with SLI scored 49.7% for ACC3 versus 85% for ACC1. For MMHL, the mean rate of production of ACC1 was high as well, attaining 88.8% and in RE it was as much as 95%, in contrast to the mean production rates for ACC3, 80.9% for MMHL, and 85% for RE. ACC3 avoidance moreover lingered well beyond childhood, attesting to the status of ACC3 as a persistent marker of atypical language development stemming from different etiologies. To sum up, most crucially for the present study, ACC3 was significantly more subject to avoidance than ACC1 in both TD 6-year-olds and in adolescents with SLI.

Various reasons have been put forth to account for the difference in performance between object clitics of the third person as compared to those of the first person (Delage, Durrleman & Frauenfelder in press; Tuller et al. 2011), one being that morphological marking of gender is obligatory on ACC3 (*le*—masculine, *la*—feminine), although not on ACC1 (*me*—either masculine or feminine). Therefore producing ACC3 would be more complex than ACC1 because it requires dealing with both gender marking and syntactic movement. ACC1 has never been explored in children with ASD; however, despite the simpler morphosyntax associated with ACC1, it is likely to pose problems for this population. This is because individuals with ASD face specific challenges associated with the marking of first person in general, regardless of cliticization. Indeed from the first publications on this condition, it has been noted that nominative pronouns of the first and second person are often inverted (Kanner 1943), a trait arguably related to deficits in perspective shifting and theory of mind (Baron-Cohen, Leslie & Frith 1985; Lee, Hobson & Chiat 1994; Mizuno et al. 2011; Evans & Demuth 2012). The present work also assesses ACC1 in children with ASD and compares their performance to that of children with SLI. Given the attested difficulties with deictic shift and mentalizing in ASD, children with this disorder are likely to show a specific deficit with ACC1 that may distinguish their syntactic profile from that of children with SLI, who as has been explained, perform well with ACC1.

Still on the issue of links between syntactic deficits and cognition, recent work has highlighted a relationship between grammar and working memory (WM) (Adams & Gathercole 2000; Bentea, Durrleman, & Rizzi 2016; Montgomery, Magimairaj & O'Malley 2008; Poll et al. 2013). The crucial idea is that mastery of complex grammatical constructions includes the storing and manipulating of verbal sequences, and WM is precisely a system that temporarily stores and manipulates information via the phonological loop, the central executive, and the episodic buffer (Baddeley 2007). The phonological loop is responsible for storing incoming memory traces of phonological information for a few seconds and then rehearsing information so as to revive memory traces, the central executive is responsible for directing and controlling the information stored in the phonological loop, and the episodic buffer is responsible for storing chunks of information that have been integrated from the different memory subsystems. The limited working memory systems of young children are thus hypothesized to cause them to lag behind adults for the production of syntactically complex structures (Grüter 2006; Jakubowicz 2011).

Producing an accusative clitic of the third person indeed requires keeping in mind its gender (as well as its referent, which is outside of the domain of the discourse participants), while simultaneously operating a syntactic movement placing the clitic in a noncanonical, preverbal, position (see Figure 1).

As such, properties of working memory seem to be involved in third person clitic mastery, namely, the storing and processing of information over short periods of time (Baddeley 1993). Pursuing this reasoning, various researchers have hypothesized that the syntactic complexity associated with ACC3 in French places a heavy load on a working memory, which is still developing in its capacity in young children (Delage, Durrleman, & Frauenfelder in press; Grüter 2006; Prévost 2006; Tuller et al. 2011). This limitation is expected to disappear with the normal maturation of working memory, thus freeing up resources essential for the processing of complex structures. Still, empirical support for this hypothesis is sparse. One study by Grüter and Crago (2012) reports a relationship between third person clitic production and working memory in the context of L2 French, revealed by a negative correlation between the digit span task and performance on clitic omission by native Chinese-speaking children. Mateu (2015) also reported that performance on third person accusative clitics correlated with performance on nonword repetition in Spanish-speaking children aged 2–3. These results are in line with the idea that producing accusative clitics involves retaining morphosyntactic information in memory while linking this information to two positions: the preverbal position where the clitic is "spelled-out" after

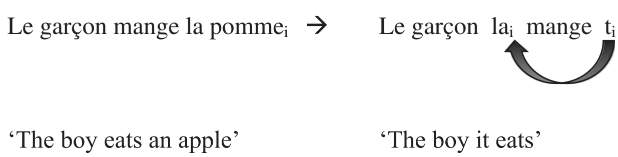


Figure 1. Producing an accusative clitic: Maintaining the referent while applying syntactic movement yielding noncanonical ordering.

syntactic movement and the canonical, postverbal position, and that this cognitive manipulation would be challenging for immature systems due to limited computational resources (Booth, MacWhinney & Harasaki 2000).

In atypical contexts of language acquisition, such as in SLI, limitations in working memory would persist with age and consequently reduce mastery of complex grammatical elements later than in TD (Jakubowicz & Tuller 2008; Delage & Frauenfelder 2012). In line with this view, difficulties in verbal WM have been reported to relate to grammatical weaknesses in instances of pathology such as SLI (Montgomery, Evans & Gillam 2009; Delage & Frauenfelder 2012) and ASD (Eigsti 2009). For SLI, Delage & Frauenfelder (2012) found that working memory scores[2] predicted children's performance in the comprehension, repetition, and spontaneous production of complex sentences (i.e., with embedded clauses). Concerning ASD (Eigsti 2009), memory as measured by nonword repetition was found to capture significant and unique variance in syntactic complexity (51%) as measured by the Index of Productive Syntax (Scarborough 1990). More specifically regarding accusative clitics, this relation has never before been examined in SLI or ASD.

If clitics, in particular of the third person, indeed build upon cognitive capacities such as working memory, then increased working memory capacities in SLI and ASD should contribute to their mastery. In light of this, we propose to experimentally examine the relation between accusative clitics and working memory in our clinical populations and expect to observe a link between successful processing of these elements and increased working memory resources.

To sum up, recent work exploring syntax in ASD has identified morphosyntactic deficits and argued that these are independent of nonverbal reasoning but relate to working memory. These characteristics are reminiscent of SLI, leading some researchers to claim that there is an overlap in syntactic profiles between these two conditions. With this study, we further investigate the nature of syntactic impairment in ASD, its parallelism with SLI, and its potential dissociation or relation to other aspects of cognition, namely, nonverbal intelligence, working memory, and, in a second phase, mental state attribution or "theory of mind" (ToM). We predict that a subgroup of children with ASD will perform significantly worse than TD peers on the production of third person accusative clitics and that their performance with this element will not significantly differ from that of children with SLI. In addition, we expect the specific ToM deficit in ASD to be related to significantly weaker production of first person accusative clitics. Finally, if working memory capacities are related to the morphosyntactic complexity associated with third person accusative clitic production, then performance on an independent working memory measure should correlate with performance on these clitics in both clinical groups under investigation.

2. Methodology

2.1. *Participants*

Our participants included 21 individuals with ASD aged 5–16 (M = 9;07), 22 individuals with SLI also aged 5–16 (M = 9;07), as well as age-matched controls and younger controls whose characteristics will be presented for each task. Typically-developing children master clitics from age 5–6 (see, e.g., Zesiger et al. 2010), explaining why we did not recruit children younger than this age. As for the higher cutoff, previous work examining the acquisition of clitics in language-impaired groups has also studied groups past age 16 years in the aim of determining if difficulty with clitics persists with age (see, e.g., Tuller et al. 2011). We ensured that our clinical groups did not differ for chronological age (p = .5) or for nonverbal reasoning (p = .5) as measured by The Raven's Progressive Matrices (Raven, Court, & Raven, 1998).[3] Characteristics of the two clinical groups are presented in Table 1.

[2]Measured by a variety of simple and complex span tasks, including nonword repetition, serial memory, forward and backward digit span, as well as counting span.

[3]The particularity of this standardized intelligence measure is that it is essentially nonverbal, including 36 items focusing on visual problem solving.

Table 1. Characteristics of Participants with ASD and SLI.

Group	N	Sex	Age Range (year; month)	Age: M (SD) (year; month)
ASD	21	19 M; 2 F	5;09–16;09	9;07 (2;10)
SLI	22	14 M; 8 F	5;10–16;02	9;08 (3;00)

Participants with ASD were recruited through parent associations in French-speaking Switzerland ("Autisme Genève" and "Autisme Suisse Romande") and the "Réseau Dys/10" in Lyon (France),[4] which is a specialized network in developmental disorders (such as SLI, dyslexia, or autism). All of these participants were diagnosed with ASD by a qualified clinician according to DSM-IV-TR criteria (APA 2000), as implemented in the ADOS (Lord et al. 1999) and ADI-R (Lord, Rutter & LeCouteur 1994). Aside from an ASD diagnosis, children had to be able to comprehend and produce sentences of at least four words in order to participate in the study. No inclusionary criterion was set for Intelligence Quotient (IQ), thus representing the large range of nonverbal abilities attested across the autistic spectrum and allowing us to explore the relation between language skills and nonverbal abilities. Appendix A provides the raw scores obtained with Raven's progressive matrices and the percentile ranges of all individuals with ASD.[5] Nine individuals present a score equal or inferior to the 5th percentile and thus can be identified as having an intellectual weakness.

Participants with SLI were diagnosed by speech and language therapists working in private offices in France or Switzerland. As is common practice with this condition, a selection criterion was an absence of intellectual retardation (checked with a score superior to the 5th percentile in the progressive matrices of Raven), and we also required competency with sentences of at least four words for this study. All participants were monolingual French speaking or native bilinguals. For the latter, one of the parents always addressed the child in French from birth (10 ASD and 4 SLI). There were no differences between the monolingual and bilingual children for language scores, be it for the ASD group (p values between .1 and .7) or for the SLI group (p values between .4 and .7).[6] The control groups came from local French and Swiss schools. All these children were native French speakers; they did not present any particular academic or language difficulty and thus did not receive speech or language therapy. Approval for this study was obtained from the Ethics Committee of the Faculty of Psychology at the University of Geneva. Parents of participants provided informed, written consent for their children to participate in the research.

2.2. *Procedure*

All children were tested individually by one experimenter either in the child's home or in the office of their speech and language therapists. Experimental tasks were conducted to evaluate the production of first and third person accusative clitics (the latter being considered as a clinical marker of SLI). We also administered standardized tasks assessing general morphosyntax, verbal working memory (digit-span task and nonword repetition), as well as nonverbal reasoning (Raven's Progressive Matrices). Note that, due to the non-normal distribution of the data (confirmed by the Shapiro-Wilk test), our analyses were conducted with nonparametric tests, with ANOVA by ranks (Kruskal–Wallis test) in order to reveal group effects, the Mann-Whitney test for intergroup comparisons and the Wilcoxon test for intragroup comparisons, associated with Spearman's rank correlations.

[4]It is relevant to note that there is no difference between French from France and French from Switzerland for the clitics under investigation.

[5]The raw score corresponds to the number of correct answers (maximum score = 36). In this task, norms are given as percentile ranges. For statistical convenience, we converted the percentile ranges into midpoint percentiles (e.g., 5th to 10th percentile is transformed into 7.5th percentile), along the lines of Zebib et al. (2013).

[6]See Appendix B for more information regarding this bilingual variable, which did not show a relationship in our sample for any of the factors explored in this work.

2.3. *Tasks*

2.3.1. *Standardized assessment of expressive grammar*

Expressive grammar was assessed using a computerized, sentence-completion task known as the Bilan Informatisé de Langage Oral 3C (Khomsi et al. 2007). Different morphosyntactic features were assessed by this task, such as verbal and nominal inflections, spatial prepositions, and passives. As in (4), children hear an utterance corresponding to a first picture. Then they have to complete a second utterance that corresponds to the second picture. Each item is scored 0, 1, or 2 depending on the child's performance and the item's complexity. This test is standardized with children of a large age range, from 5 to 15 years old. The maximum score is 36.

(4) Ici, le garçon est debout ; là, la fille… → **est assise**
'Here, the boy is standing; there, the girl… → **is sitting**'

2.3.2. *Production probe of pronoun clitics*

In order to test production of first and third accusative clitics (respectively called ACC1 and ACC3), we administered a shortened version of the Production Probe for Pronoun Clitics (Tuller et al. 2011), which was initially used by its authors to highlight the ACC1/ACC3 gap. We adapted this task by removing items that require the production of reflexive clitics and by adding fillers to avoid all items requiring clitics. The final task contains 16 test items preceded by 2 pretest items and interspersed with 4 fillers that all require a structure with an intransitive verb (see Table 2). Appendix C provides the complete list of all target items. The experimenter elicited clitics by asking a question about a drawing appearing on a computer screen, as illustrated in Table 3 (for the two pretest items).

Accusative clitics elicited in this task were always obligatory; their omission would thus lead to an ungrammatical response. Moreover, whenever the child answered with a structure other than the one expected (that is, with a verb that does not require an accusative clitic), the experimenter asked the child to reformulate his/her answer by specifying the verb to use. Following is an illustration of how this was accomplished with an example such as that in (5), where the expected response is *Elle me lèche* ('It's licking me') and the child provided an utterance that does not require a clitic (5a) so is prompted to correct the utterance with the appropriate transitive verb (5b).[7]

(5a) La vache est sympa
'The cow is nice'

(5b) Mais comment tu dirais avec lécher ?
'But how could you say it with 'lick'?'

Table 2. Clitic Pronouns Elicited by the Shortened Version of the PPPC.

2 Pretest items		16 test items		4 fillers
1 x ACC1	1 x ACC3	8 x ACC1	8 x ACC3	All intransitive verbs
me			4 masc. **le**	Ex: *il nage* 'he's swimming'
	la	**me**	4 fem. **la**	

[7]This same strategy was applied throughout the elicitation probe for both ACC1 and ACC3. To illustrate how this applied to ACC3: *Que fait Thomas à Marie?* 'What is Thomas doing to Mary?'. Expected response: *il la pousse* 'He is pushing her.' Inappropriate response: *Va-t-en!* 'Go away!' Experimenter: *oui, regarde ça s'appelle 'pousser'. Que fait Thomas à Marie? Comment tu pourrais dire avec 'pousser'*? 'Yes, look, that's called "to push." What is Thomas doing to Mary? How could you say it with "push"?' Expected response: *il la pousse* 'He is pushing her.' For the ASD group, 76 prompts for reformulation were necessary, and 21 of them yielded a correct production including the relevant clitic, i.e., 28%. For the SLI group, 47 prompts for reformulation occurred with 14 leading to correct responses, i.e., 30%.

Table 3. Examples of Stimuli.

ACC3	Experimenter: *Que fait le monsieur avec sa voiture?* 'What's the man doing with his car?' Expected response: *Il **la** lave.* He her washes 'He's washing it.'
ACC1	Experimenter: *Lui, il dit « Hé, Marie, que fait la vache? » Maintenant, toi, tu es Marie, qu'est-ce que tu réponds?* '*He* says « Hey, Mary, what's the cow doing? » 'Now, *You* are Mary, what do you answer?' Expected response: *Elle **me** lèche.* She me licks 'It's licking me.'

2.3.3. *Nonword repetition*

We used an abbreviated version of the nonword repetition BELEC task (Mousty, Leybaert, Alegria, Content, & Moraïs, 1994), from which we had removed the series of less (phonologically) complex nonwords (with consonant-vowel structures) present in the initial task.[8] Children had to repeat 20 (prerecorded) nonwords, all phonologically complex (with consonant-vowel-consonant structures), organized in five series increasing in length (one to five syllables, such as *bli, plubro, kragrinblan, fleublifrouklébro)*. The task was stopped when children missed three correct repetitions within one series (i.e., within one level of length). The final score was the total number of correctly repeated syllables.

2.3.4. *Digit span tasks*

Verbal short-term memory was assessed through standardized digit span tasks taken from the Wechsler Intelligence Scale for Children (WISC IV, Wechsler 2005). These tasks consisted of orally presenting a series of digits increasing in length from two to nine, which participants had to immediately repeat aloud, either in the same order (yielding the forward digit span) or in the reversed order (yielding the backward digit span). The length of the longest list a participant can remember is their overall digit span. The task was stopped when children missed two out of two trials within one level. The forward digit span is thus a measure of verbal short-term memory resources, requiring participants to maintain the correct order of an increasing sequence of digits and to repeat it. The backward digit span is rather a measure of central executive functioning, requiring the retaining and recalling of a given number sequence coupled with the manipulating of this sequence to provide the reverse order of digits. In this so-called *complex-span* task, an additional processing demand is thus combined with the memory task of recalling a list of items. It distinguishes itself from a *simple-span* task, which requires simple storage of information, such as forward digit span (see Gathercole et al. 2004).

3. Results

3.1. *Standardized assessment of expressive grammar*

Standard deviations obtained by the ASD group show a mean score of −2.7 (SD = 2.4), which did not differ from that of the SLI group (M = −2.1, SD = 1.8, p = .4).[9] The two populations, considered as groups, thus display impairment in morphosyntactic abilities. Despite the large age range, there was no correlation between chronological age and grammar in SLI (p = .8) or ASD (p = .3). These results, however, hide a large intersubject variability with scores ranging from −7.1 to 1.5 SD in the ASD

[8]We removed these phonologically simple nonwords in order to shorten the task and avoid ceiling effects on these extremely simple nonwords.

[9]As the expressive grammar task is a standardized task, we do not have scores for a specific TD sample, but real norms.

Table 4. Individual Expressive Grammar Scores Obtained by ASD and SLI Participants.

ASD Participants		SLI Participants	
Age (year;month)	Standard Deviation	Age (year;month)	Standard Deviation
5;09	−0.1	5;10	−0.1
6;01	1.5	6;08	−2.0
6;07	0.2	6;09	−1.3
7;01	−1.7	7;00	−1.5
7;03	−5.7	7;04	−1.5
7;08	−1.8	7;04	−2.1
7;11	−2.7	7;06	−0.6
7;11	−2.1	7;09	−1.8
8;06	−6.8	8;02	−5.2
8;07	−6.4	8;06	−0.2
9;01	−5.2	8;10	−6.8
9;07	−3.5	9;04	−3.1
9;08	−3.5	9;06	−4.3
9;10	−1.5	9;07	−4.7
10;10	−1.1	9;09	−2.2
10;11	−0.5	10;01	−3.1
11;04	−3.5	10;03	−0.8
12;07	−7.1	12;01	−1.7
13;00	−4.4	12;10	−1.3
14;00	−1.1	14;11	−1.6
16;09	−0.9	15;09	−0.1
		16;02	−0.3

Scores within the norm are >−1 SD.

group and from −6.8 to −0.1 *SD* in the SLI group (see Table 4 for individual results). More specifically, it is interesting to note that five participants with ASD obtained a score within the norm (> −1 *SD*), which was also the case for six participants with SLI.[10]

3.2. *Production probe of pronoun clitics*

Performance of individuals with ASD and with SLI is compared to that of control participants of the same mean age (N = 28, Age range = 7;09–11;09, M = 9;07),[11] thus called "age-matched" (AM) controls, as well as to younger control children matched on expressive grammar (based on the mean scores obtained by the groups of ASD and of SLI in our standardized assessment of expressive grammar), called "language-matched" (LM) controls. This LM group includes 16 children with a mean age of 7;08 (range 7;01–8;00 years), two years younger than the mean age of both our clinical groups.

Scores here include only production of clitics that were entirely correct (i.e., also showing accurate gender marking in the case of ACC3). ANOVA by ranks (Kruskal-Wallis tests) revealed group effects for both ACC3—H (3, 87) = 16.8, $p < .001$—and ACC1—H (3, 87) = 13.3, p = .004. More precisely, results obtained by each population in producing ACC3 display clear deficits on this clinical marker (of language

[10]This result can seem surprising in light of a diagnosis of SLI. A series of observations may be relevant here. Firstly, on the well-respected standardized tests used by professionals to diagnose diagnosed SLI, these children did indeed score below the threshold required for this diagnosis (test of Syntactic comprehension [ECOSSE, Lecocq 1996], which is the French adaptation of the Test for Reception of Grammar [TROG, Bishop 1983]). Secondly, all participants with SLI had a level of language difficulty that continued to justify their being included in remediation programs, which is where they were recruited. Thirdly, the "BILO" standardized test used here comprises items that are very frequently used by speech therapists during their language evaluations and interventions. Due to this, participants with SLI may have received a little "training" on these items. However, amongst these six participants with SLI who managed to perform well on the BILO, three nevertheless display severe phonological disorders (with SD < −2 on nonword repetition), two present difficulties on ACC3 production (with low percentages of correct production, compared to age-matched controls), and only one child does not present any other difficulties. Since he is among the oldest participants and had already benefited from a lengthy speech and language therapy, we hypothesize that he may have compensated for his initial difficulties.

[11]These controls do not differ from the ASD and SLI groups for age (p = .5 for both comparisons).

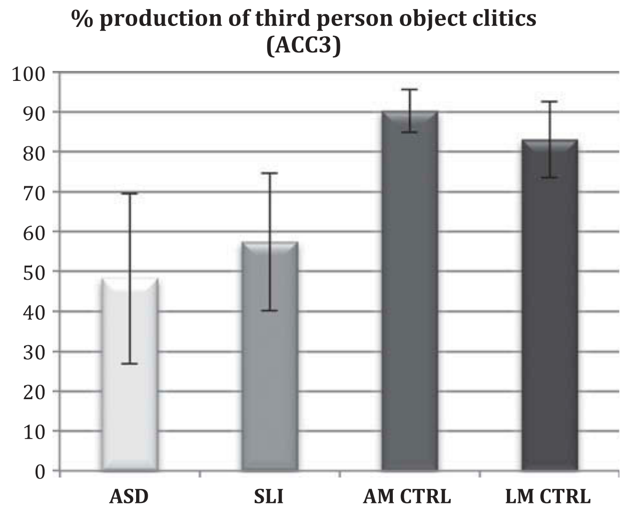


Figure 2. Production rates of ACC3 in ASD, SLI, and control groups (age-matched "AM" and language-matched "LM" CTRL).

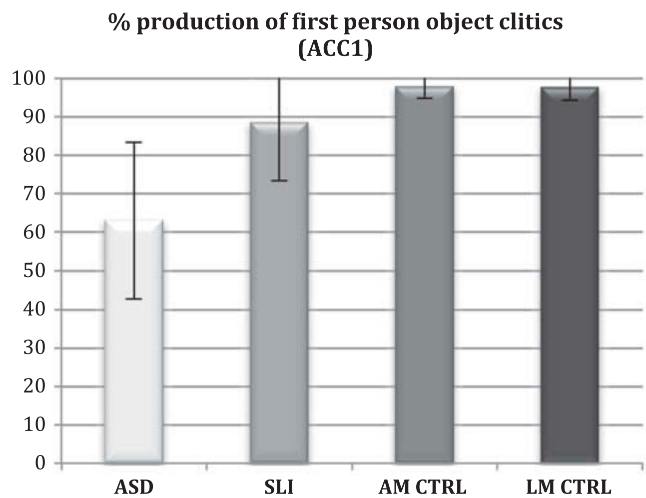


Figure 3. Production rates of ACC1 in ASD, SLI, and control groups (age-matched "AM" and language-matched "LM" CTRL).

impairment).[12] Children with ASD scored an average of 48% and those with SLI 57%, a performance that differed from that of (1) the 28 age-matched control participants, who showed significantly better performance scoring an average of 90.3% (AM > ASD: U = 142.5, p = .001; AM > SLI: U = 141.5, p < .001); and (2) the 16 language-matched control participants, who scored an average of 83% (LM > ASD: U = 94, p = .021; LM > SLI: U = 100, p < .024). These results are illustrated in Figure 2. However, performance of the groups with ASD and SLI did not significantly differ from one another for this item (p = .5). Regarding ACC1, the ASD group performed significantly below both controls (AM > ASD: U = 173, p = .001; LM > ASD: U = 101, p = .014) and the SLI group (U = 159.5, p = .037), as illustrated in Figure 3. On the other hand, performance of the SLI group did not differ from that of AM and LM controls on ACC1 (p = 0.4 and 0.6 respectively).

[12]Interestingly, this difficulty is limited to accusative clitics, since both ASD and SLI groups display good performance for production rates of third person nominatives clitics (85% and 94% respectively).

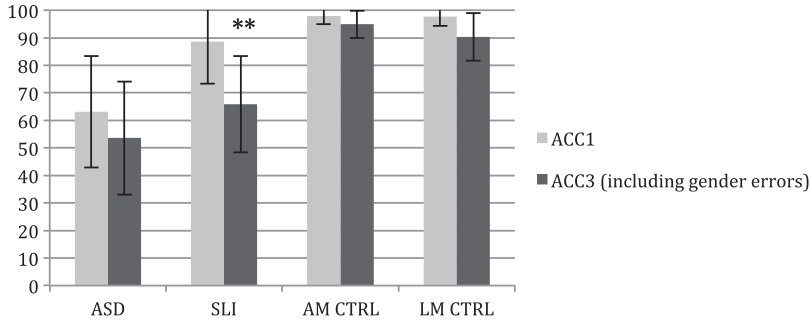


Figure 4. Production rates of ACC1 and ACC3 (including gender error) for ASD, SLI, and control groups (age-matched "AM" and language-matched "LM" CTRL).

Table 5. Type and Number of Unexpected Answers Produced by ASD and SLI Groups Instead of ACC1 and ACC3.

	Unexpected Answers	ASD Group	SLI Group
ACC1	*N* total	57	42
	Omissions	31 (54%)	22 (52%)
	DP production	6 (11%)	16 (38%)
	Inversion of participant roles	6 (11%)	0
	Others (inappropriate and nonresponse)	14 (25%)	4 (10%)
ACC3	*N* total	87	75
	Omissions	45 (52%)	17 (23%)
	DP production	20 (23%)	29 (39%)
	Gender errors	9 (10%)	19 (25%)
	Inversion of participant roles	4 (5%)	0
	Reflexive clitics	3 (3%)	2 (3%)
	Others (inappropriate and nonresponse)	6 (7%)	8 (11%)

The production rates for ACC3 until this point only concern items that were entirely correct, without any gender errors. However, in order to determine whether rates for ACC3 are statistically different from those for ACC1, we have to take into account the production rates of ACC3 including gender errors. This is because, as indicated earlier, ACC1 is neutralized for gender (i.e., has the same form regardless of the gender of the referent) and thus cannot be confusing for children with respect to the gender feature. According to this way of counting, children with ASD produced ACC3 at an average of 54% and those with SLI at an average of 66%, so that these groups' performance is not statistically different on this variable ($p = .4$), although it is significantly below performance of the two control groups (AM > ASD: $U = 112.5$, $p < .001$; AM > SLI: $U = 144$, $p < .001$; LM > ASD: $U = 74$, $p = .004$; LM > SLI: $U = 99$, $p = .016$). A comparison via Wilcoxon tests of production rates of ACC1 and of ACC3 with gender errors revealed that ACC1 was produced significantly more than ACC3 by the SLI group ($T = 8$, $p = .005$), whereas no such difference was found in the ASD group ($p = .25$). Such comparisons were not relevant for the two groups of control children given that these children performed at high levels (> 90%) for the two variables, as illustrated in Figure 4.[13]

Concerning error types (see Table 5), for ACC1, the majority of errors of both clinical groups were those of omission (6) and production of a Determiner Phrase (DP), as in (7). Otherwise, children with ASD produced some structures in which participant roles were inversed (8). As for ACC3, the groups displayed different patterns: Children with ASD omitted the clitic (9) more frequently, whereas the children with SLI tended to produce a DP rather than produce an

[13]Note that the difference between ACC1 and ACC3, in favor of ACC1, has been shown in younger typically developing children, aged 6, by Tuller et al. (2011), as already explained in the introduction.

objectless sentence (10). Gender errors were attested in both groups, especially by the children with SLI, as shown in (11).

(6) Experimenter: Hé, René, que fait l'éléphant ? Toi, tu es René. Dis-moi ce que tu réponds. 'Hey René, what is the elephant doing? *You* are René. What do you answer?'
Expected answer: il m'écrase. 'it is squashing me'
ASD (9;7): il écrase. 'it is squashing'

(7) SLI (10;4): l'éléphant écrase René. 'the elephant is squashing René'

(8) Experimenter : Hé, Thomas, que fait le chien ? Toi, tu es Thomas. Dis-moi ce que tu réponds. 'Hey Thomas, what is the dog doing? *You* are Thomas. What do you answer?'
Expected answer: il me lèche. 'It is licking me'
ASD (7;8): je lèche le chien. 'I'm licking the dog'

(9) Experimenter:
Que fait Thomas avec l'argent ? 'What is doing Thomas with the money?'
Expected answer: il le cache He is hiding it [+masc]'
ASD (7;11): il cacher 'He hide'

(10) SLI (5;10): il cache l'argent 'He is hiding the money'

(11) SLI (9;8): il la cache 'He is hiding it [+fem]'

3.3. *Nonword repetition*

ANOVA by ranks revealed a strong group effect for the score of correctly repeated syllables—H (2, 87) = 48.2, $p < .001$. Both participants with ASD and SLI show lower performance than controls of the same chronological age (N = 44, Age range = 5;09–12;09, M = 9;04, Controls > ASD: U = 196.5, $p < .001$; Controls > SLI: U = 11, $p < .001$). If we look at performance across groups, the SLI group displayed the most pronounced deficit since these children performed behind the group with ASD (U = 79.5, $p < .001$). Figure 5 illustrates these results. Note that we did not have available data of language-matched control children for this task, so we compared performance of our clinical groups to that of 16 younger children aged 5 to 6 (M age = 6;01). Interestingly, in spite of their young age, these children displayed better performance than our participants with ASD (U = 90, p = .017) and with SLI (U = 10.5, $p < .001$).

3.4. *Digit span tasks*

ANOVA by ranks showed group effects for both forward—H (2,87) = 14.5, $p < .001$, and backward digit span—H (2,87) = 17.2, $p < .001$). However, the results of ASD and SLI groups are similar in that they both performed significantly lower than age-matched controls[14] (the same age-matched control participants as for nonword repetition) and did not differ from each other (p = .4 for forward digit span, p = .2 for backward digit span). Figures 6 and 7 illustrate these results.

3.5. *Subgroups*

Group performance needs to be interpreted with caution because upon closer inspection a significant subgroup of children with ASD showed intact grammatical skills, contrary to those with SLI. Indeed a subgroup of seven children with ASD (i.e., one-third of the total group) obtained scores within the norm for their age on standardized syntax (> −1.65 SD) and did not differ from age-matched TD controls on ACC3 (93% for this subgroup of ASD versus 90% for controls, p = .3) nor on ACC1

[14]Forward digit span: Controls > ASD → U = 315.5, p = .022, Controls > SLI → U = 206.5, $p < .001$; Backward digit span: Controls > ASD → U = 234, p = .013, Controls > SLI → U = 235.5, $p < .001$.

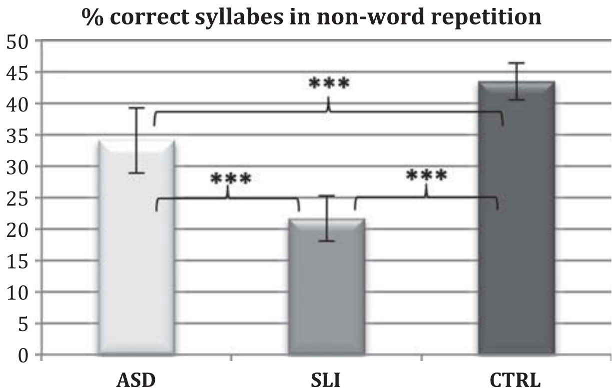


Figure 5. Mean number of correctly repeated syllables in nonword repetition: ASD, SLI, and CTRL (age-matched controls).

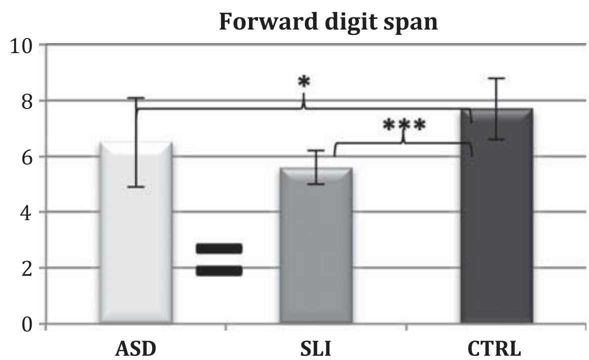


Figure 6. Scores obtained in forward digit span: ASD, SLI, and CTRL (age-matched controls).

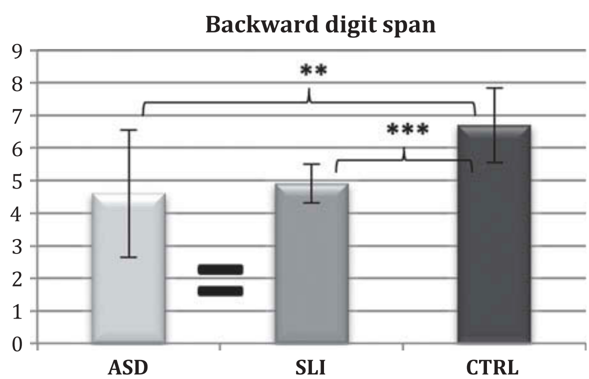


Figure 7. Scores obtained in backward digit span: ASD, SLI, and CTRL (age-matched controls).

(p = .7). Logically, scores of this subgroup are better than those of the SLI on key measures of syntax such as expressive grammar (U = 32, p = .023) or ACC3 production (U = 25.5, p = .008).

When this subgroup is compared to the other participants with ASD, they do not differ on nonverbal reasoning (p = .1), nor on age (p = .3), but they are significantly better on expressive grammar (U = 5, p = .001) and on production rates of ACC3 and ACC1 (U = 3, p < .001; U = 21, p = .025 respectively). More interestingly, they also differ on working memory scores (nonword repetition: U = 19, p = .027, forward digit span: U = 22.5, p = .049, backward digit span: U = 22.5, p = .047). We thus find a relationship between better working memory capacities and better complex syntax in ASD, a relationship that we directly test with correlational analyses.

3.6. *Links*

One aim of our work was to explore links between working memory and syntax in our two clinical groups. Since nonverbal reasoning may obscure the results of these analyses, we conducted partial correlations by controlling the variable of nonverbal reasoning, using (partial) Pearson's correlations. In both groups, correlations emerged only with ACC3. For the ASD group, correlations were found between ACC3 and nonword repetition (r = .46, p = .040), forward digit span (r = .51, p = .021) and backward digit span (r = .46, p = .039). In the SLI group, the only correlation found was between ACC3 and backward digit span (r = .53, p = .014).

In contrast, nonverbal abilities in ASD as measured by the Raven's were unrelated to language performance, be it for third person accusative clitics (p = .15) or for the standardized assessment of general grammar (p = .16). The same dissociations arose for SLI (p = .4 and p = .7 respectively). Another result confirmed the absence of relationship between nonverbal reasoning and syntactic performance in ASD: Indeed, if we compare the scores obtained by the nine participants with ASD who display probable intellectual weakness (with scores on the progressive matrices of Raven equal or inferior to the 5th percentile) to those of the 11 individuals with percentile ranges in the norms (> 5th percentile), no difference is detectable in syntactic performance, neither for scores on third person accusative clitics (p = .2) nor for scores on the standardized general assessment of grammar (p = .3).[15]

4. Interim discussion

The first aim of this study was to determine to what extent children with ASD display a similar syntactic profile to that of children with SLI through an investigation of the production of accusative clitics. Results indicate that, as a group, children with ASD do not perform significantly differently from those with SLI, neither for global syntax nor for ACC3, which is a clinical marker of SLI. A persistent difficulty with ACC3 is attested in both groups, who perform worse than both age-matched and language-matched controls. However, children with SLI outperform those with ASD for ACC1. This may be accounted for in terms of our task's reliance on theory of mind abilities, which is a core deficit in ASD (Baron-Cohen, Leslie & Frith 1985). Indeed, so as to respond correctly by producing an ACC1, children had to answer in the place of another character (see example 8). In order to verify this hypothesis, we conducted a follow-up study in this specific population, as described in section 5.

The second aim of this work was to explore links between complex syntax and working memory in our clinical groups. In terms of group performance, ASD and SLI did not differ for working memory as measured by digit-span tasks. Working memory deficits is one of the hallmarks of SLI (Gathercole & Baddeley 1990; Montgomery 2002; Hick, Botting & Conti-Ramsden 2005; Montgomery, Evans & Gillam 2009; Marinis & Saddy 2013) and have also been reported for ASD (Eigsti 2009; Roberts, Rice & Tager-Flusberg 2004; Kjelgaard & Tager-Flusberg 2010; Riches et al. 2010). Our results confirm that participants with ASD indeed present working memory deficits and are in line with the hypothesis of an overlap between this condition and SLI (Kjelgaard & Tager-Flusberg 2010; Roberts, Rice & Tager-Flusberg 2004;

[15]Interestingly, no differences were found for nonword repetition (p = .1), nor for forward and backward digit span (p = .7 and p = .5), showing that these measures of working memory do not seem related to nonverbal reasoning abilities.

Tager-Flusberg 2006), plausibly due to a shared etiology (Bishop 2010). Recall, however, that ASD outperforms SLI on working memory as measured by nonword repetition. A possible explanation for inferior performance in SLI compared to ASD on nonword repetition is that *phonological* working memory is a core deficit of SLI (Gathercole & Baddeley 1990), while this seems to be less systematically affected in ASD, although it remains a vulnerable domain (Eigsti & Schuh 2008).

Links between working memory abilities and elements displaying complex morpho-syntax, namely ACC3, were found in both ASD and SLI. While correlational analyses cannot prove a causal relation between variables, these findings are nevertheless compatible with the hypothesis that morpho-syntactic complexity solicits working memory resources, thus populations with working memory deficits are expected to show deficits in the realm of grammatical development (Montgomery 2002; Montgomery, Evans & Gillam 2009). Regarding the precise working memory measure which related to ACC3 in SLI, this involved the only complex span task we had. Indeed, as we have already noted, producing an accusative clitic requires both maintaining and manipulating verbal information, as is the case for the backward digit span. Such a relationship between complex spans and complex syntax has already been demonstrated in the literature, notably by Montgomery, Magimairaj & O'Malley (2008), who showed that complex-span results specifically explained 30% of the variance in the comprehension of complex sentences[16] in typically developing children, in contrast to results on simple spans. In our own study (Delage & Frauenfelder 2012), conducted on 48 TD children aged 6 to 12, we also showed that complex spans predict syntactic performance better than simple spans for complex utterances (such as embedded clauses) in spontaneous language samples.

In ASD, ACC3 performance is furthermore linked to nonword repetition (NWR) and forward digit span, i.e., measures that only involve the maintaining of verbal information. These simpler aspects of memory are arguably also involved in syntactic operations, but then why should they uniquely show the relation in ASD? We speculate that this could be the result of the large heterogeneity in working memory scores in this population, even for simpler memory tasks. Indeed, their increased variation in performance in turn increased the chance for correlations to emerge, while the SLI group showed a more homogeneous performance on simpler working memory measures. Thus, standard deviations in SLI on simpler measures were 7.1 (for nonword repetition) and 1.5 (for forward digit span), compared to the group with ASD, who showed standard deviations of 10.4 (for nonword repetition) and 3.2 for (for forward digit span). Previous work has also identified links in ASD between simple spans such as nonword repetition and higher-order syntax (Eigsti & Bennetto, 2001; Kjelgaard & Tager-Flusberg 2010), suggesting that simpler spans recurrently relate to syntax in this population, plausibly once again because of pronounced fluctuations in performance in this domain.

To sum up, difficulties on working memory measures were revealed for ASD and SLI and crucially found to correlate with performance on third person accusative clitics in both groups. In contrast, nonverbal reasoning did not correlate with syntax at all.

5. Follow-up study: Theory of mind

A subgroup of 14 children with ASD, aged 5;09 to 16;09 (*M* = 10;00, *SD* = 3;03)[17] were available to participate in a preliminary follow-up study focusing on theory of mind, as well as 14 TD children, aged from 6;04 to 9;01 (*M* = 7;09, *SD* = 1;01).[18] Theory of Mind (ToM) refers to the ability to attribute mental states to others and reason on the basis of this knowledge. One method for evaluating ToM is the False Belief (FB) task, such as the Sally-Anne. The Sally-Anne paradigm

[16]For complex sentences, they included structures like passives, while simple sentences did not express movement and thus respected canonical word order.

requires children to predict where a character, Sally, will first look for an object that was moved to a new location (by Anne) in her absence (Baron-Cohen, Leslie & Frith 1985). In order to succeed, children have to understand Sally's perspective is different from their own, such that she has a belief that does not correspond to reality but rather to a representation that is false (Dennett 1978). Typically-developing children generally succeed at this task around the age of 4 to 5 years (Wellman, Cross & Watson 2001; Milligan, Astington, & Dack 2007), while many children with ASD of higher nonverbal mental age still fail (Baron-Cohen, Leslie & Frith 1985; Happé 1995; Yirmiya et al. 1998; Naito & Nagayama 2004). Given this, various researchers have suggested that communicative and social difficulties associated with this population are the result of their difficulties with mentalizing and perspective switching (Frith, Morton & Leslie 1991; Frith 2001; Tager-Flusberg 2007). In our follow-up study, we explore to what extent such a deficit is related to difficulties with ACC1 production in ASD.[19]

5.1. *Material*

We used the Sally and Anne paradigm, (Baron-Cohen, Leslie & Frith 1985) to assess ToM abilities in children with ASD, illustrating the following storyline with puppets:

> This is Sally, and this is Anne. Sally has a basket, and Anne has a box. Sally has a marble, and she puts it into her basket. She then goes out. Anne takes out Sally's marble and puts it into her box while Sally is away. Now Sally comes back and wants to play with her marble. Where will Sally look for her marble? (test question) Where is the marble really? (control question) Where was the marble in the beginning? (control question).

In order to answer the critical "belief" question accurately (i.e., "Where will Sally look for her marble?"), children must grasp that Sally has a mental state that is different from reality and their own and that her false belief will make her look inside the empty basket rather than where the marble really is, namely, within the box. Correct responses to the other "control" questions confirm that children are aware of where the marble is in reality and that they remember where it was initially placed, thus ensuring that children are keeping track of the story. We included four stories based on this classical Sally-Anne task in our assessment of ToM, as outlined in Table 6.

Note that for the false belief condition (in 7), we decided to add the term "first" (*en premier* in French) at the end of the question. This is because it has been shown to enhance TD children's performance on the task (Surian & Leslie 1999). This task was composed in all by 16 control questions (8 reality questions and 8 memory questions) and 4 test (false belief) questions.

5.2. *Results*

All of the 14 participants with ASD succeeded in the questions of reality and of memory. We thus consider that they were able to understand the task. As for the test question (false belief), five children succeeded in the four questions, whereas the others displayed some difficulties: Three participants failed in all four questions, one passed only one question, one obtained half correct responses (i.e., 2/4), and the other four participants obtained 3/4 correct responses. The TD control group succeeded in all of the questions, including on false beliefs. Those children with ASD who

[17]As for expressive grammar, these 14 children obtained a mean standard deviation of −2.5 on standardized assessment of grammar, and they displayed production rates of ACC3 and ACC1 of 54% and 60%.

[18]This subset of participants was determined based solely on availability to participate.

[19]We did not test children with SLI for ToM, given that the aim of this testing was to explain difficulties in ACC1, which were absent from SLI. However, as one reviewer points out, this would have been appropriate as we predict good performance for this group, although some studies have reported a ToM delay in SLI (Holmes 2002; Tucker 2004; Roqueta et al. 2013). It is worth noting that the ToM delay reported was detected in very young children with SLI, while studies assessing ToM in SLI subjects of a comparable age to our participants have found no difficulties with these tasks, unlike their ASD peers (Leslie & Frith 1988; Perner et al. 1989; Ziatas, Durkin & Pratt 1998). Finally, it has been shown that even in young children with SLI, no ToM delay is detectible when the linguistic complexity of the task is kept low (Miller 2001), unlike what has been shown for ASD where ToM difficulties have thus been argued to be more central to their condition (Colle, Baron-Cohen & Hill 2007).

Table 6. Verbal False-Belief Task Format.

1. A and B are both placed in the scenario at the beginning.
2. "A puts the [object] into [location 1]."
3. "A goes out to play/shop." The experimenter hides A from the child's view.
4. "B takes the [object] and puts it in [location 2]."
5. "A comes back." The experimenter brings A back into the child's view.
6. "A wants the [object]."
7. Test question: *Où est-ce que A va chercher [objet] en premier*? ('Where will A look for the [object] first?')
8. Reality question: *Où est [objet] en réalité*? ('Where is the [object] now?')
9. Memory question: *Où était [objet] au début*? ('Where was the [object] at the beginning?')

performed similarly to the controls, therefore, were those who had ceiling performance. The ASD group with this level of performance consisted of five children, while there were nine who did not show this ability. Table 7 presents the individual results of this ASD group (age, performance on the ToM task, on the clitics task as well as on expressive grammar).

Given the sizes of these groups, results have to be interpreted with precaution; however, the preliminary indication is that these two groups of intact versus atypical theory of mind performance did not differ on nonverbal reasoning (p = .1) nor on age (p = .6), nor on ACC3 (p = .1), but interestingly, they differed on ACC1 production rates (U = 7, p = .035). More specifically, the group with intact ToM showed high performance on ACC1 (M = 96.4%, SD = 9.4), while the group with ToM difficulties clearly showed lower performance on this item (M = 40.3%, SD = 45).

6. General discussion and conclusion

This study focused on the grammatical abilities of children with ASD with two central goals in mind: first, to determine to what extent a subgroup of children with ASD displays impairments that resemble those attested in SLI, and second, to increase our understanding of how these impairments may be related to difficulties in other areas of cognition such as nonverbal reasoning, working memory, and theory of mind. Overall scores on general morphosyntax as well as on the production of accusative clitics reveal quantitatively similar deficits for both clinical groups which were unrelated to nonverbal abilities. These results are relevant for the debate around the existence of a language disorder in ASD that would either resemble SLI (Kjelgaard & Tager-Flusberg 2010; Roberts, Rice & Tager-Flusberg 2004; Tager-Flusberg 2006; Zebib et al. 2013), possibly due to comorbidity (Bishop 2010), or rather resemble nonspecific language impairment resulting from general cognitive ability (Tager-Flusberg et al. 1990; Howlin 2003). Our findings uphold that like children with SLI, the language performance of many children with ASD seems affected in the realm of grammar and dissociated from nonverbal reasoning skills.

Table 7. ASD Group: Age, Individual Results for the ToM Task, the Clitics Task (ACC3/ACC1 rates), and the Expressive Grammar (Standard Deviations).

Age	ToM Capacity	ACC3 (%)	ACC1 (%)	Expressive Grammar (SD)
5;09	intact	25	100	−0.1
6;01	intact	87.5	100	1.5
6;07	intact	75	75	0.2
7;08	atypical	0	50	−1.8
7;11	atypical	12.5	87.5	−2.6
8;07	atypical	62.5	0	−6.4
9;01	atypical	0	100	−5.2
9;07	atypical	75	0	−3.4
10;11	atypical	100	25	−0.5
11;04	atypical	87.5	100	−3.5
12;07	atypical	0	0	−7.1
13;00	atypical	25	0	−4.3
14;00	intact	100	100	−1.1
16;09	intact	100	100	−0.9

Regarding the error types on ACC production of each clinical group, errors of omission occurred more frequently in ASD, possibly due to their nonmastery of the pragmatic licensing requirements of such elements (Terzi et al. 2014). Indeed, accusative clitics in spoken French are subject to legitimate omission in certain pragmatically appropriate discourse contexts (Tuller et al. 2011), while individuals on the autistic spectrum frequently display impairments specifically in discourse abilities and pragmatics (Tager-Flusberg 1999).[20]

As for the group with SLI, errors of gender marking were most predominantly present, which can be plausibly accounted for in terms of their specific difficulties with the morphological marking of this feature (Chillier-Zesiger et al. 2006; Silveira 2011; Tuller et al. 2011; Keij et al. 2012). Despite these subtle distinctions in error patterns, global performance with ACC3 suggests a similarity in the language deficits attested in ASD and SLI, arguably due to the underlying difficulty with syntactic movement shared by both (for ASD see Zebib et al. 2013, Durrleman, Marinis & Franck, in press; for SLI see Lely & Harris 1990; Ebbels & van der Lely 2001; Stavrakaki 2001; Friedmann & Novogrodsky 2004).

However, we have seen that variation in the language abilities of ASD are considerable, and upon closer inspection a subgroup of children with spared grammatical capacities emerges (Roberts, Rice & Tager-Flusberg 2004; Tager-Flusberg 2006; Kjelgaard & Tager-Flusberg 2010; Perovic, Modyanova & Wexler 2013; Terzi et al. 2014). This variation seems to be related to working memory abilities, as has also been suggested in previous work (Eigsti & Schuh 2008; Eigsti 2009). The link between working memory and ACC3 arguably stems from the heightened computational load associated with this element. Indeed, we hypothesized that producing ACC3 would particularly tax the child's working memory resources, as compared to clitics of the first person. This is because in addition to the complexity associated with syntactic movement, ACC3 furthermore requires keeping in working memory the gender of the referent of ACC3 (i.e., masculine or feminine), which is not required for ACC1 (the latter being neutralized in gender) (Delage, Durrleman, & Frauenfelder in press; Tuller et al. 2011). Another potential source of difficulty associated with ACC3 is the need to establish a reference that is outside of the discourse context, involving a larger set of possible referents as compared to ACC1, whose referential options are restricted to discourse participants, i.e., the speaker or the hearer (Tuller et al. 2011).

Many children with ASD struggled also with ACC1, in contrast to those with SLI, who performed well on this element. It is not uncommon for individuals on the autistic spectrum to display difficulty with simpler grammatical constructions (Durrleman & Franck 2012; Perovic, Modyanova & Wexler 2013; Durrleman, Marinis & Franck, in press) while the same constructions are preserved in SLI (Friedmann & Novogrodsky 2004; Novogrodsky & Friedmann 2010). This may point to a difference between the language profiles of these two conditions and thus deserves further investigation.[21] Recall also that the task used to elicit ACC1 required perspective shifting, and thus the lower scores that resulted could be linked to the well-documented ToM deficit in ASD (Baron-Cohen, Leslie & Frith 1985). This account was initially suggested by the inappropriate responses provided by children with ASD, who often reversed the subject and object participant (thematic) roles, and gained further support from the results of our follow-up study. Indeed, this subsequent study showed that higher ToM abilities were related to higher performance with first person accusative clitics in ASD. As such, the difficulty with ACC1 was predominant in the subgroup with ToM deficits but largely absent from the group with spared ToM. ACC1 and ToM thus seem linked in ASD, which is clearly a highly heterogeneous population regarding both of these capacities.

[20]As an illustration of legitimate clitic omission, consider the example from Fonagy (1985): While an ACC would be required in written French, a null object is acceptable because of the presence of a sufficiently salient discourse topic:

—*Voulez-vous que je vous donne mon numéro de téléphone*? —*Non, je connais* __.

—'Want-you that I you give my number of telephone?' — 'No, I know.'

[21]Given the highlighted relationship between perspective switching and performance with ACC1, we may speculate that other pronominals involving a shift in perspective could also be vulnerable in ASD, e.g., reflexive clitics elicited with a similar protocol to ours. As children with SLI perform well with these items (see, e.g., Tsimpli 2001; Tuller et al. 2011; Novogrodsky and Friedmann 2010), difficulty in ASD would once again indicate a difference in the language profiles of these populations. We leave this for future work.

Indeed, while ToM impairments are frequently reported for ASD, it is relevant to note that studies assessing false beliefs in children with ASD have systematically shown that a proportion of the participants always succeeds, ranging from a minority (e.g., 20%, as in Baron-Cohen, Leslie & Frith 1985) to a majority (e.g., 60%, as in Prior, Dahlstrom, & Squires 1990). In line with our findings, recent work has suggested that higher ToM success relates to higher language skills (Happé 1995; Tager-Flusberg 2000; Tager-Flusberg & Joseph 2005; Lind & Bowler 2009; Durrleman & Franck 2015; Durrleman et al. 2015).

In sum, our study suggests novel meaningful ways to parse the heterogeneity attested in autism. Our findings show that a subgroup of children with ASD displays similar syntactic difficulties to those of SLI, while another subgroup displays intact language abilities, and that these differences relate to other cognitive capacities such as working memory and theory of mind.[22] Consequently, those children on the autistic spectrum with poorer grammatical skills require appropriate therapeutic programs that will not only focus on pragmatics or social communication but also on formal aspects of language such as syntax. In addition, the links between syntax and aspects of cognition such as working memory and theory of mind deserve closer attention in future research. For instance, training studies further assessing these language-cognition relationships, and clearly determining the direction of the influence, may potentially contribute to shaping clinical interventions.

ORCID

Stephanie Durrleman http://orcid.org/0000-0003-1883-5703

References

Adams, A.-M. & S. E. Gathercole. 2000. Limitations in working memory: Implications for language development. *International Journal of Language and Communication* 35. 95–116.

American Psychiatric Association (APA). 2000. *The diagnostic and statistical manual of mental disorders* (4th ed., revised). Washington, DC: Author.

American Psychiatric Association (APA). 2013. *Diagnostic and statistical manual of mental disorders*, 5th edn., 5–25. Arlington, VA: American Psychiatric Publishing.

Arosio, F., C. Branchini, L. Barbieri & M. T. Guasti. 2014. Failure to produce direct object clitic pronouns as a clinical marker of SLI in school-aged Italian speaking children. *Clinical Linguistics and Phonetics* 28(9). 639–663.

Avram, L. & M. Coene. 2008. Object clitics as last resort. Implications for language acquisition. In S. Baauw, J. van Kampen & M. Pinto (eds.), *The acquisition of Romance languages: Selected papers from the Romance Turn II*, 361–387. Utrecht: Netherlands Graduate School of Linguistics/Landelijke (LOT).

Avram, L., A. Sevcenco & I. Stoicescu. 2013. Clinical markers of specific language impairment and developmental dyslexia in Romanian: The case of accusative clitics. Unpublished manuscript, University of Bucharest.

Baddeley, A. D. 1993. Working memory and conscious awareness. In A. Collins & S. Gathercole (eds.), *Theories of memory*, 11–28. Hillsdale, NJ: Lawrence Erlbaum.

Baddeley, A. D. 2007. *Working memory, thought, and action*. New York: Oxford University Press.

Baltaxe, C. 1977. Pragmatic deficits in the language of autistic adolescents. *Journal of Pediatric Psychology* 2. 176–180.

Baron-Cohen, S. 1997. Hey! It was just a joke! Understanding propositions and propositional attitudes by normally developing children and children with autism. *Israel Journal of Psychiatry* 37. 174–178.

Baron-Cohen, S., A. M. Leslie & U. Frith. 1985. Does the autistic child have a "theory of mind"? *Cognition* 21(1). 37–46.

Bartak, L., M. Rutter & A. Cox. 1975. A comparative study of infantile autism and specific developmental receptive language disorder: I. The children. *British Journal of Psychiatry* 126(2). 127–145.

Bentea, A., Durrleman, S., & L. Rizzi. 2016. Refining intervention: The acquisition of featural relations in object A-bar dependencies. *Lingua* 169. 21–41.

Bishop, D. V. M. 1983. *The test for reception of grammar*. Manchester, UK: University of Manchester, Age and Cognitive Performance Research Centre.

[22]This appears to be coherent with recent findings that distinct ASD subgroups (identified based on functional neuroimaging phenotypes in the first years of life) relate to different language trajectories, with those individuals with better language responding to speech by recruiting not only the canonical language areas of the brain but also the subcortical regions involved in emotion and memory, in a fashion more close to that observed in typically developing controls (Lombardo et al. 2015).

Bishop, D. V. M. 2003. Autism and Specific Language Impairment: Categorical distinction or continuum ? In G. Bock & J. Goode (eds.), *Autism: neural basis and treatment possibilities: Novartis Foundation Symposium*, 213–226. Chichester, UK: John Wiley & Sons.

Bishop, D. V. M. 2010. Overlaps between autism and language impairment: Phenomimicry or shared etiology? *Behavior Genetics* 40. 618–629.

Blom, E., A. Kuntay, M. Messer, J. Verhagen & P. Leseman. 2014. The benefits of being bilingual: Working memory of bilingual Turkish-Dutch children. *Journal of Experimental Child Psychology* 128. 105–119.

Bonifacci, P., Giombini, L., Bellocchi, S., & S. Contento. 2011. Speed of processing, anticipation, inhibition and working memory in bilinguals. *Developmental Science* 14. 256–269.

Booth, J. R., MacWhinney, B., & Y. Haraskai, 2000. Developmental differences in visual and auditory processing of complex sentences. *Child Development* 71. 981–1003.

Bortolini U., M. Caselli, P. Deevy & L. Leonard. 2002. Specific language impairment in Italian: The first steps in the search for a clinical marker. *International Journal Language and Communication Disorders* 37(2). 77–93.

Cardinaletti, A. & M. Starke. 1999. The typology of structural deficiency: A case study of the three classes of pronouns. In Henk van Riemsdijk (ed.), *Clitics in the languages of Europe*, 145–233. Berlin: Mouton de Gruyter.

Chillier, L., M. Arabatzi, L. Baranzini, S. Cronel-Ohayon, T. Deonna & S. Dubé. 2001. The acquisition of French pronouns in normal children and in children with specific language impairment (SLI). Paper presented at Early Lexicon Acquisition (ELA), December 5–8, Lyon, France [CD].

Chillier-Zesiger, L., M. Arabatzi, L. Baranzini, S. Cronel-Ohayon & T. Deonna. 2006. The acquisition of French pronouns in normal children and in children with Specific Language Impairment (SLI). Unpublished manuscript, University of Geneva.

Chin, Y. H. & V. Bernard-Opitz. 2000. Teaching conversational skills to children with autism: Effect on the development of a theory of mind. *Journal of Autism and Developmental Disorders* 30(6). 569–583.

Clark, E. 1985. The acquisition of Romance with special reference to French. In D. I. Slobin (ed.), *The cross-linguistic study of language acquisition*, 49–60. Mahwah, NJ: Lawrence Erlbaum.

Coene, M. & L. Avram. 2011. An asymmetry in the acquisition of accusative clitics in child Romanian. *Studies on Language Acquisition* 43. 39–68.

Colle, L., S. Baron-Cohen & J. Hill. 2007. Do children with autism have a theory of mind? A non-verbal test of autism vs. Specific Language Impairment. *Journal of Autism and Developmental Disorders* 37(4). 716–723.

Delage, H., Durrleman, S., & U. H. Frauenfelder. In press. Disentangling sources of difficulty associated with the acquisition of accusative clitics in French. *Lingua*.

Delage, H. & U. H. Frauenfelder. 2012. The relation between working memory and syntactic development in childhood. Paper presented at the 14th meeting of the International Clinical Phonetics and Linguistics Association, June 27–30, University College Cork, Ireland.

Dennett, D. 1978. Beliefs about beliefs. *Behavioral and Brain Sciences* 4. 568–570.

Durrleman, S. & J. Franck. 2012. Atypical subject relative clause processing deficit in children with autism. Poster presented at the Architectures and Mechanisms for Language Processing (AMLaP) conference, September 6–8, Riva del Garda, Italy.

Durrleman, S. & J. Franck. 2015. Exploring links between language and cognition in autism spectrum disorders: Complement sentences, false belief, and executive functioning. *Journal of Communication Disorders* 54. 15–31.

Durrleman, S., T. Marinis & J. Franck. In press. Syntactic complexity in the comprehension of wh-questions and relative clauses in typical language development and autism. *Applied Psycholinguistics*.

Durrleman, S., Burnel, M., Reboul, A., Thommen, E., Foudon, N., Sonié, S, Reboul, A., & P. Fourneret. 2016. The language cognition interface in Autism Spectrum Disorders: Complement sentences and false belief reasoning. *Research in Autism Spectrum Disorders* 21. 109–120.

Ebbels, S. & L. van der Lely. 2001. Metasyntactic therapy using visual coding for children with severe persistent SLI. *International Journal of Language and Communication Disorders* 36(Suppl.). 345–350.

Eigsti, I.-M. 2009. *Syntax and working memory in preschool children with autism*. Koln, Germany: Lap Lambert Academic Pub.

Eigsti, I.-M., & L. Bennetto. 2001. *Syntactic and memory functions in young children with autism*. San Diego, CA: Paper presented at the International Society for Developmental Psychobiology.

Eigsti, I.-M. & J. M. Schuh. 2008. Neurobiological underpinnings of language in autism spectrum disorders. *Annual Review of Applied Linguistics* 28. 128–149.

Engel de Abreu, P. M. 2011. Working memory in multilingual children: Is there a bilingual effect? *Memory* 19. 529–537.

Evans, K. E. & K. Demuth. 2012. Individual differences in pronoun reversal: Evidence from two longitudinal case studies. *Journal of Child Language* 39. 162–191.

Fonagy, I. 1985. J'aime Ø, Je connais Ø: verbes transitifs à objet latent ['I love Ø, I know Ø : transitive verbs with implicit objects']. *Revue Romane* 21. 3–35.

Fortunato-Tavares, T. M. 2012. *Grammar and pragmatics in specific language impairment and autism spectrum disorder*. Saõ Paolo: University of Saõ Paolo dissertation.

Friedmann, N. & R. Novogrodsky. 2004. The acquisition of relative clause comprehension in Hebrew: A study of SLI and normal development. *Journal of Child Language* 31. 661–681.

Frith, U. 2001. Mind blindness and the brain in autism. *Neuron* 32(6). 969–979.

Frith, U., J. Morton & A. M. Leslie. 1991. The cognitive basis of a biological disorder: Autism. *Trends in Neurosciences* 10. 433–438.

Gathercole, S. E. & A. D. Baddeley. 1990. Phonological memory deficits in language disordered children: Is there a causal connection? *Journal of Memory and Language* 29(3). 336–360.

Gathercole, S. E., S. J. Pickering, B. Ambrige & H. Wearing. 2004. The structure of working memory from 4 to 15 years of age. *Developmental Psychology* 40. 177–190.

Gavarró, A. 2012. Third person clitic production and omission in Romance SLI. In P. Guijarro-Fuentes & P. Larrañaga (eds.), *Pronouns and clitics in early language*, 79–104. New York: De Gruyter/Mouton.

Goetz, P. 2003. The effects of bilingualism on theory of mind development. *Bilingualism: Language and Cognition* 6(1). 1–15.

Grüter, T. 2006. *Object clitics and null objects in the acquisition of French*. Montreal: McGill University dissertation.

Grüter, T. & M. Crago. 2012. Object clitics and their omission in child L2 French: The contributions of processing limitations and L1 transfer. *Bilingualism: Language and Cognition* 15(3). 531–549.

Hambly, C. & E. Fombonne. 2012. The impact of bilingual environments on language development in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders* 42(7). 1342–1352

Hamann, C., S. Ohayon, S. Dubé, U. H. Frauenfelder, L. Rizzi, M. Starke & P. Zesiger. 2003. Aspects of grammatical development in young French children with SLI. *Developmental Science* 6(2). 151–158.

Hamann, C., L. Rizzi, & U. H. Frauenfelder. 1996. On the acquisition of subject and object clitics in French. In H. Clahsen (ed.), *Generative perspectives on language acquisition*, 309–334. Philadelphia: John Benjamins.

Happé, F. 1995. Understanding minds and metaphors: Insights from the study of figurative language in autism. *Metaphor and Symbolic Activity* 10(4). 275–295.

Hick, R. F., N. Botting & G. Conti-Ramsden. 2005. Short-term memory and vocabulary development in children with Down syndrome and children with specific language impairment. *Developmental Medicine and Child Neurology* 47(8). 532–538.

Holmes, A. M. 2002. Theory of mind and behavior disorders in children with specific language impairment [Abstract]. *Dissertation Abstracts International*: *Section B: The Sciences and Engineering 62*. 11B.

Howlin, P. 1984. The acquisition of grammatical morphemes in autistic children: A critique and replication of the findings of Bartolucci, Pierce, and Streiner, 1980. *Journal of Autism and Developmental Disorders* 14. 127–136.

Howlin P. 2003. Outcome in high-functioning adults with autism with and without early language delays: Implications for the differentiation between autism and Asperger syndrome. *Journal of Autism and Developmental Disorders* 33. 3–13.

Jakubowicz, C. 2011. Measuring derivational complexity: New evidence from typically developing and SLI learners of L1 French. *Lingua* 121. 339–351.

Jakubowicz C., L. Nash, C. Rigaut, & C.-L. Gérard. 1998. Determiners and clitic pronouns in French-speaking children with SLI. *Language Acquisition* 7(2–4). 113–160.

Jakubowicz, C. & C. Rigaut. 2000. L'acquisition des clitiques nominatifs et des clitiques objets en Français [The acquisition of nominative clitics and object clitics in French]. *Canadian Journal of Linguistics* 45. 119–157.

Jakubowicz, C. & L. Tuller. 2008. Specific language impairment in French. In D. Ayoun (ed.), *Studies in French applied linguistics*, 97–134. Amsterdam: John Benjamins.

Kanner, L. 1943. Autistic disturbances of affective contact. *Nervous Child* 2. 217–250.

Katsos, N. 2015. Les enfants avec autisme peuvent-ils devenir de bons bilingues? In H. Delage & S. Durrleman (eds.), *Langage et cognition dans l'autisme*, 65–70. Paris: Editions de Boeck Solal.

Keij, B., L. Cornips, R. van Hout, A. C. J. Hulk & J. van Emmerik. 2012. Knowing versus producing: The acquisition of grammatical gender and the definite determiner in Dutch by L1-TD, L1-SLI, and eL2 children. *Linguistic Approaches to Bilingualism* 2. 379–403.

Ketelaars, P., J. Cuperus, K. Jansonius, L. Verhoeven, 2009. Pragmatic language impairment and associated behavioral problems. *International Journal of Language & Communication Disorders/Royal College of Speech & Language Therapists* 45(2). 204–214.

Ketelaars, P., J. Cuperus, J. Van Daal, K. Jansonius & L. Verhoeven. 2009. Screening for pragmatic language impairment: The potential of the children's communication checklist. *Research in Developmental Disabilities* 30 (5). 952–960.

Khomsi, A., J. Khomsi, A. Parbeau-Guéno & F. Pasquet. 2007. *Bilan informatisé de langage oral au Cycle III et au collège (BILO3C)* [Computerized evaluation of oral language]. Paris: Editions du CPA.

Kjelgaard, Margaret & Helen Tager-Flusberg. 2010. An investigation of language impairment in autism: Implications for genetic subgroups. *Language and Cognitive Processes* 16(2–3). 287–308.

Kurita, H. 1985. Infantile autism with speech loss before the age of 30 months. *Journal of the American Academy of Child Psychiatry* 24. 191–196.

Lecocq, P. 1996. *L'E.CO.S.SE: Une ´epreuve de compréhension syntaxico-s´emantique* [An evaluation of syntactic and semantic comprehension]. Villeneuve d'Ascq, France: Presses Universitaires du Septentrion.

Lee, A., R. Hobson & S. Chiat. 1994. I, you, me and autism: An experimental study. *Journal of Autism and Developmental Disorders* 24. 155–176.

Lely, H. K. J. van der & M. Harris. 1990. Comprehension of reversible sentences in specifically language impaired children. *Journal of Speech and Hearing Disorders* 55. 101–117.

Leslie, A. M. & U. Frith. 1988. Autistic children's understanding of seeing, knowing, and believing. *British Journal of Developmental Psychology* 6. 315–324.

Lind, S. & D. Bowler. 2009. Language and theory of mind in autism spectrum disorder: The relationship between complement syntax and false belief task performance. *Journal of Autism and Developmental Disorders* 39(6). 929–937.

Lombardo, M. V., K. Pierce, L. T. Eyler, C. C. Barnes, C. Ahrens-Barbeau, S. Solso, K. Campbell & E. Courchesne. 2015. Different functional neural substrates for good and poor language outcome in autism. *Neuron*. http://dx.doi.org/10.1016/j.neuron.2015.03.023.

Lord, C. & R. Paul. 1997. Language and communication in autism. In D. J. Cohen & F. R. Volkmar (eds.), *Handbook of autism and pervasive development disorders*, 2nd edn, 195–225. New York: John Wiley & Sons.

Lord, C., S. Risi, P. DiLavore, C. Shulman, A. Thurm & A. Pickles. 2006. Autism from two to nine. *Archives of General Psychiatry* 63(6). 694–701.

Lord, C., M. Rutter, P. C. DiLavore & S. Risi. 1999. *Autism Diagnostic Observation Schedule–WPS (ADOS–WPS)*. Los Angeles: Western Psychological Services.

Lord, C., M. Rutter & A. LeCouteur. 1994. Autism diagnostic interview—revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders* 24. 659–668.

Luo L., Luk G., & E. Bialystok. 2010. Effect of language proficiency and executive control on verbal fluency performance in bilinguals. *Cognition* 114. 29–41

Marinis, T. & D. Saddy. 2013. Parsing the passive: Comparing children with Specific Language Impairment to sequential bilingual children. *Language Acquisition: A Journal of Developmental Linguistics* 20(2). 155–179.

Martin-Rhee M. M., & E. Bialystok. 2008. The development of two types of inhibitory control in monolingual and bilingual children. *Bilingual Language Cognition* 11. 81–93.

Mateu, V. E. 2015. Object clitic omission in child Spanish: Evaluating representational and processing accounts. *Language Acquisition* 22. 240–284.

Miller, C. A. 2001. False-belief understanding in children with specific language impairment. *Journal of Communication Disorders* 34. 73–86.

Milligan, K., J. W. Astington & L. A. Dack. 2007. Language and theory of mind: Meta-analysis of the relation between language ability and false-belief understanding. *Child Development* 78(2). 622–646.

Mizuno, A., Y. Liu, D. L. Williams, T. A. Keller, N. J. Minshew & M. A. Just. 2011. The neural basis of deictic shifting in linguistic perspective-taking in high-functioning autism. *Brain* 134(8). 2422–2435.

Montgomery, J. W. 2002. Understanding the language difficulties of children with specific language impairment: Does verbal working memory matter? *American Journal of Speech-Language Pathology* 11. 77–91.

Montgomery, J. W., J. L. Evans & R. Gillam. 2009. Relation of auditory attention on complex sentence comprehension in children with specific language impairment: A preliminary study. *Applied Psycholinguistics* 30. 123–151.

Montgomery, J. W., B. Magimairaj & M. O'Malley. 2008. The role of working memory in typically developing children's complex sentence comprehension. *Journal of Psycholinguistic Research* 37. 331–354.

Mousty, P., Leybaert, J., Alegria, J., Content, A. & J. Moraïs. 1994. *B.E.L.E.C.: Batterie d'évaluation du langage et de ses troubles*. Bruxelles: Laboratoire de psychologie expérimentale, Université libre de Bruxelles.

Naito, M. & K. Nagayama. 2004. Autistic children's use of semantic common sense and theory of mind: A comparison with typical and mentally retarded children. *Journal of Autism and Developmental Disorders* 34(5). 507–519.

Novogrodsky, R. & N. Friedmann. 2010. Not all dependencies are impaired in Syntactic-SLI: Binding in children with a deficit in Wh-movement. In K. Franich, K. M. Iserman & L. L. Keil (eds.), *Proceedings of the 34th annual Boston University Conference on Language Development [BUCLD 34]*, 1–10. Somerville, MA: Cascadilla Press.

Ozonoff, S. & J. N. Miller. 1996. An exploration of right-hemisphere contributions to the pragmatic impairments of autism. *Brain and Language* 52(3). 411–434. doi:10.1006/brln.1996.0022.

Paradis, J., M. Crago & F. Genesee. 2003. Object clitics as a clinical marker of SLI in French: Evidence from French-English bilingual children. In B. Beachley, A. Brown & F. Conlin (eds.), *Proceedings of the 27th annual Boston University Conference on Language Development [BUCLD 27]*, 638–649. Somerville, MA: Cascadilla Press.

Parisse, C. & C. Maillart. 2004. Développement morphosyntaxique des enfants ayant des troubles de développement du langage: Des données francophones [Morphosyntactic development of children with language impairment: French data]. *Enfance* 56. 21–26.

Pérez-Leroux, A. T., M. Pirvulescu & Y. Roberge. 2008. Null objects in child language: Syntax and the lexicon. *Lingua* 118(3). 370–398.

Perner, J., U. Frith, A. M. Leslie & S. Leekam. 1989. Exploration of the autistic child's theory of mind: Knowledge, belief, and communication. *Child Development* 60. 689–700.

Perovic, A., N. Modyanova & K. Wexler. 2013. Comprehension of reflexive and personal pronouns in children with autism: A syntactic or pragmatic deficit? *Applied Psycholinguistics* 34(4). 813–835.

Pierce, S. & G. Bartolucci. 1977. A syntactic investigation of verbal autistic, mentally retarded, and normal children. *Journal of Autism and Childhood Schizophrenia* 7. 121–134.

Poll, G. H., C. A. Miller, E. Mainela-Arnold, K. D. Adams, M. Misra & J. S. Park. 2013. Effects of children's working memory capacity and processing speed on their sentence imitation performance. *International Journal of Language & Communication Disorders/Royal College of Speech & Language Therapists* 48(3). 329–342.

Prévost, P. 2006. The phenomenon of object omission in child L2 French. *Bilingualism: Language and Cognition* 9. 263–280.

Prior, M., B. Dahlstrom & T. L. Squires. 1990. Autistic children's knowledge of thinking and feeling states in other people. *Journal of Child Psychology and Psychiatry* 31(4). 587–601.

Ratiu, I. & Azuma, T. 2015. Working memory capacity: Is there a bilingual advantage? *Journal of Cognitive Psychology* 27. 1–11.

Raven, J. C., Court, J. H., & J. Raven. 1998. Progressive matrices standard (PM38). Éditions du centre de psychologie appliquée.

Reddy, V., E. Williams & A. Vaughn. 2002. Sharing humour and laughter in autism and Down's syndrome. *British Journal of Psychology* 93(2). 219–242.

Rice, M. L., K. Wexler & P. L. Cleave. 1995. Specific language impairment as a period of extended optional infinitive. *Journal of Speech and Hearing Research* 38. 850–863.

Riches, N. G., T. Loucas, G. Baird, T. Charman & E. Simonoff. 2010. Sentence repetition in adolescents with specific language impairments and autism: An investigation of complex syntax. *International Journal of Language & Communication Disorders* 45(1). 47–60.

Roberts, J., M. L. Rice & H. Tager-Flusberg. 2004. Tense marking in children with autism. *Applied Psycholinguistics* 25. 429–448.

Roqueta, A., C. Adrian, J. E. Clemente & N. Katsos. 2013. Which are the best predictors of theory of mind delay in children with specific language impairment? *International Journal of Language and Communication Disorders* 48(6). 726–737.

Scarborough, H. 1990. Index of productive syntax. *Applied Psycholinguistics* 11. 1–22.

Schaeffer, J. In press. Linguistic and other cognitive abilities in children with Specific Language Impairment as compared to children with High-Functioning Autism. *Language Acquisition*.

Short, C. B. & E. Schopler. 1988. Factors relating to age of onset in autism. *Journal of Autism and Developmental Disorders* 18. 207–216.

Silveira, M. 2011. *Specific language impairment revisited: Evidence from a psycholinguistic investigation of grammatical gender abilities in Brazilian Portuguese-speaking children*. London: University College London dissertation.

Stavrakaki, S. 2001. Comprehension of reversible relative clauses in specifically language impaired and normally developing Greek children. *Brain and Language* 77. 419–431.

Surian, L. & A. M. Leslie. 1999. Competence and performance in false belief understanding: A comparison of autistic and normal 3-year-old children. *British Journal of Developmental Psychology* 17(1). 141–155.

Tager-Flusberg, H. 1996. Current theory and research on language and communication in autism. *Journal of Autism and Developmental Disorders* 26. 169–172.

Tager-Flusberg, H. 1999. A psychological approach to understanding the social and language impairments in autism. *International Review of Psychiatry*, 11. 25–334.

Tager-Flusberg, H. 2000. Language and understanding minds: Connections in autism. In S. Baron-Cohen, H. Tager-Flusberg & D. Cohen (eds.), *Understanding other minds: Perspectives from developmental cognitive neuroscience*, 124–149. Oxford: Oxford University Press.

Tager-Flusberg, H. 2004. Do autism and specific language impairment represent overlapping language disorders? In M. L. Rice & S. F. Warren (eds.), *Developmental language disorders: From phenotypes to etiologies*, 31–52. Mahwah, NJ: Lawrence Erlbaum.

Tager-Flusberg, H. 2006. Defining language phenotypes in autism. *Clinical Neuroscience Research* 6. 219–224.

Tager-Flusberg, H. 2007. Evaluating the theory-of-mind hypothesis of autism. *Current Directions in Psychological Science* 16. 311–315.

Tager-Flusberg, H., S. Calkins, T. Nolin, T. Baumberger, M. Anderson & A. Chadwick-Dias. 1990. A longitudinal study of language acquisition in autistic and Down syndrome children. *Journal of Autism and Developmental Disorders* 20. 1–21.

Tager-Flusberg, H. & R. M. Joseph. 2005. How language facilitates the acquisition of false-belief understanding in children with autism. In J. W. Astington & J. A. Baird (eds.), *Why language matters for theory of mind*, 298–318. New York: Oxford University Press.

Terzi, A., T. Marinis, K. Francis & A. Kotsopoulou. 2012. Crosslinguistic differences in autistic children's comprehension of pronouns: English vs. Greek. In A. K. Biller & E. Y. Chung (eds.), *Proceedings of the 36th annual Boston University Conference on Language Development [BUCLD 36]*, 607–619. Somerville, MA: Cascadilla Press.

Terzi, A., T. Marinis, A. Kotsopoulou & K. Francis. 2014. Grammatical abilities of Greek-speaking children with autism. *Language Acquisition* 21(1). 4–44. doi:10.1080/10489223.2013.855216.

Theodorou, E., & Grohmann, K. K. 2015. Object clitics in Cypriot Greek children with SLI. *Lingua* 161. 144–158.

Tomblin, B. 2011. Co-morbidity of autism and SLI: Kinds, kin and complexity. *International Journal of Language & Communication Disorders* 46. 127–137.

Tsimpli, I. M. 2001. LF-interpretability and language development: A study of verbal and nominal features in Greek normally developing and SLI children. *Brain and Language* 77. 432–448.

Tsimpli, I. M. & M. Mastropavlou. 2007. Feature interpretability in L2 acquisition and SLI: Greek clitics and determiners. In H. Goodluck, J. Liceras & H. Zobl (eds.), *The role of formal features in second language acquisition*, 143–183. London: Routledge.
Tucker, L. 2004. Specific language impairment and theory-of-mind: Is normal language development an essential precursor for on time theory-of-mind development? Unpublished manuscript, University of Western Australia.
Tuller, L., H. Delage, C. Monjauze, A. G. Piller & M. A. Barthez. 2011. Clitic pronoun production as a measure of atypical language development in French. *Lingua* 121. 423–441.
van der Lely, H. K. J. (see Lely)
Van der Velde, M. 2003. *Les déterminants et les pronoms en néerlandais et en français: Analyse syntaxique et acquisition* [Determiners and pronouns in Dutch and French: Syntactic analysis and acquisition]. Paris: Universities of Paris V & VIII dissertation.
Varlokosta, S., Adriana Belletti, João Costa, Naama Friedmann, Anna Gavarró, Kleanthes K. Grohmann, Maria Teresa Guasti, Laurice Tuller, Maria Lobo, Darinka Anđelković, Núria Argemí, Larisa Avram, Sanne Berends, Valentina Brunetto, Hélène Delage, María-José Ezeizabarrena, Iris Fattal, Ewa Haman, Angeliek van Hout, Kristine Jensen de López, Napoleon Katsos, Lana Kologranic, Nadezda Krstić, Jelena Kuvac Kraljevic, Aneta Miękisz, Michaela Nerantzini, Clara Queraltó, Zeljana Radic, Sílvia Ruiz, Uli Sauerland, Anca Sevcenco, Magdalena Smoczyńska, Eleni Theodorou, Heather van der Lely, Alma Veenstra, John Weston, Maya Yachini & Kazuko Yatsushiro. 2016. A cross-linguistic study of the acquisition of clitic and pronoun production. *Language Acquisition* 23(1). 1–26.
Wechsler, D. 2005. *WISC-IV: Echelle d'Intelligence de Wechsler pour Enfants* [Weschsler intelligence scale for children], 4th edn. Paris: Les Editions du Centre de Psychologie Appliquée.
Wellman, H., D. Cross, & J. Watson. 2001. Meta-analysis of theory of mind development: The truth about false belief. *Child Development* 72. 655–684.
Yirmiya, N., O. Erel, M. Shaked & D. Solomonica-Levi. 1998. Meta-analyses comparing theory of mind abilities of individuals with autism, individuals with mental retardation, and normally developing individuals. *Psychological Bulletin* 124. 283–307.
Zebib R., L. Tuller, P. Prévost & E. Morin. 2013. Formal language impairment in French-speaking children with ASD: A comparative ASD/SLI study. In Stavroula Stavrakaki, Marina Lalioti and Polyxeni Konstantinopoulou (eds.) *Advances in language acquisition*, 472–480. Newcastle: Cambridge Scholars Publisher.
Zesiger, P., L. Chillier-Zesiger, M. Arabatzi, L. Baranzini, S. Cronel-Ohayon, J. Franck, U. H. Frauenfelder, C. Hamann & L. Rizzi. 2010. The acquisition of pronouns by French children: A parallel study of production and comprehension. *Applied Psycholinguistics* 31. 571–603.
Ziatas, K., K. Durkin & C. Pratt. 1998. Belief term development in children with autism, Asperger syndrome, specific language impairment, and normal development: Links to theory of mind development. *Journal of Child Psychology and Psychiatry* 39. 755–763.

Appendix A: Raw Scores Obtained for the Progressive Matrices of Raven and the Percentile Ranges of all Individuals with ASD

Age	*Raw Score (max = 36)*	*Percentile*
5;09	24	62.5
6;01	29	95
6;07	21	50
7;01	11	< 5
7;03	8	< 5
7;08	25	50
7;11	14	< 5
7;11	15	< 5
8;06	34	90
8;07	22	10
9;01	31	62.5
9;07	21	5
9;08	32	62.5
9;10	34	75
10;10	12	< 5
10;11	34	62.5
11;04	32	37.5
12;07	22	< 5
13;00	9	< 5
14;00	25	5
16;09	36	95

Appendix B: Bilingualism Variable

Our participants included only children who were exposed to French since birth, although some were monolingual French-speaking and others were native bilinguals, meaning that one of the parents always addressed the child in French from birth. These bilinguals were composed of 10 children with ASD and 4 with SLI.

Of these 14 bilinguals, 8 spoke a Romance language (Portuguese or Spanish) and 6 a Germanic language (English). We have verified that the group exposed to Romance did not differ from the group exposed to Germanic for their age (p = .2), their production scores of ACC3 (p = .2) and ACC1 (p = .6), nor for their scores on expressive grammar (p = .7).

That bilingualism does not negatively impact performance of children with ASD on our grammatical measures is consistent with the small but suggestive work on other areas of language that are not negatively affected by bilingualism, such as vocabulary (e.g., Hambly & Fombonne 2012) and pragmatic competence (Katsos 2015).

Another concern relevant here is that bilingualism has been reported to give rise to better performance on ToM tasks (e.g., Goetz 2003), as well as on tasks of verbal working memory (Blom et al. 2014), the other two factors whose relationship to grammatical knowledge is explored in this study. We have therefore checked that our bilingual group did not differ from our monolingual group for forward digit span (p = .2), backward digit span p = .5), and ToM (p = .4). Note that while there are numerous reports for a bilingual advantage on inhibitory, switching, and updating tasks, this advantage does not clearly extend to working memory, as we find here (Bonifacci, Gombini, Bellocchi, & Contento, 2011; Engel de Abrue, 2011; Luo, Luk, & Bialystok 2010; Martin-Rhee & Bialystok 2008; Raitu & Azuma 2015).

As a result of these considerations, we conclude that the bilingual variable does not seem to impact our findings in any significant manner.

Appendix C: List of Target Items for the Production Probe for Pronoun Clitics

ACC1:

Il me lèche	'He is licking me'
Elle me mord	'She is biting me'
Elle me lèche	'She is licking me'
Elle m'éclabousse	'She is splashing me'
Il m'écrase	'He is crushing me'
Il me pique	'He is stinging me'
Il me poursuit	'He is chasing me'
Elle me pique	'She is stinging me'

ACC3:

Il le pèse	'He is weighing him'
Elle la regarde	'She is looking at her'
Il la coiffe	'He is combing her (hair)'
Il la réveille	'He is waking her (up)'
Elle le coupe	'She is cutting it'
Elle le lave	'She is washing him'
Il le cache	'He is hiding it'
Elle la maquille	'She is making her up'